NOV 12 1999

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
UTILITY PATENT APPLICATION TRANSMITTAL LETTER

To: Assistant Commissioner for Patents
Box Patent Application
Washington D.C., 20231

Dear Assistant Commissioner:

Transmitted herewith for filing under 37 C.F.R. §1.53(b) is a Nonprovisional Utility Patent Application for a New Application entitled:

X-Y RECEIVER FOR CDMA TRANSMISSION by:

Chengke Sheng.

The filing fee is calculated as follows:

CLAIMS AS FILED AFTER AMENDING THE APPLICATION
AS SET FORTH IN THE PARAGRAPHS BELOW

FOR	NUMBER OF CLAIMS	NUMBER EXTRA	RATE	FEE
TOTAL CLAIMS	17 - 20 =	0	x $18 =	$ 0.00
INDEPENDENT CLAIMS	6 - 3 =	3	x $78 =	234.00
MULTIPLE DEPENDENT CLAIMS			$260	0.00
BASIC FEE				760.00
TOTAL FILING FEE				$ 994.00

Please charge Deposit Account No. 13-4773 for any fees required, or credit Deposit Account No. 13-4773 for any refunds. One copy of this page is enclosed for deposit account purposes.

Attorney Docket No.: SC91189A

Enclosed are:

_X_ 5 sheets of drawings and 14 pages of specification.

_X_ Newly executed Combined Declaration and Power of Attorney.

____ Copy of declaration from prior United States Patent Application No. _______ filed on _______.

_X_ A paper entitled "Authorization for Fees Under 37 C.F.R. §§1.16 and 1.17 and Petitions for Extensions of Time."

_X_ A Recordation Form Cover Sheet and an Assignment of the invention.

____ Preliminary amendment.

____ Enter the unentered 37 C.F.R. §1.116 amendment filed in the prior application.

____ Information Disclosure Citation (Form PTO-1449) and copies of the cited references therein (other than pending U.S. patent applications) are enclosed.

_X_ A Return Postcard specifically listing all enclosures.

____ Incorporation by Reference (for Continuation/Division application). The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein. Because the present application is based on a prior U.S. patent application, please amend the specification by adding the following sentence before the first sentence of the specification:

"This is based on prior United States Patent Application No. 09/000,000, filed on , which is hereby incorporated by reference, and priority thereto for common subject matter is hereby claimed."

____ Cancel claims ______ of the prior application before calculating the filing fee.

____ Priority of patent application number _______ filed on _______ in _______ is hereby claimed under 35 U.S.C. §119.

A certified copy of the foreign patent application has previously been sent.

____ Priority of U.S. Patent Application No. _______ filed on _______ is hereby claimed under 35 U.S.C. §119(e).

____ Priority of U.S. Patent Application No. _______ filed on _______ is hereby claimed under 35 U.S.C. §120.

_____ This Application is being filed by fewer than all the inventors named in the prior application. Amend the current Application by deleting the following inventors pursuant to 37 C.F.R. §1.53: _______.

_____ An assignment has been previously submitted and recorded.

_____ Other:

Please forward all correspondence to:

Harry A. Wolin
Austin Intellectual Property Law Section
7700 West Parmer Lane
MD: TX32/PL02
Austin, Texas 78729

11/5/99
Date

James L. Clingan, Jr.

James L. Clingan, Jr.
Attorney for Applicant
Registration No. 30,163
Telephone No. (512) 996-6839
Facsimile No. (512) 996-6854

X-Y RECEIVER FOR CDMA TRANSMISSION

Field of the Invention

This invention relates generally to the field of receivers of radio frequency transmissions. More particularly, this invention relates to a new receiver for code division multiple access ("CDMA") communication systems.

Related Art

Prior art communication systems have incorporated such compression techniques as frequency division multiple access ("FDMA") and time division multiple access ("TDMA"). FDMA is a multiple-access technique based on assigning each user a unique frequency band upon which transmission takes place. With TDMA, the available communication resource is divided into a number of distinct time segments, each of which can then be used for transmission by individual users.

CDMA, on the other hand, is based on spread-spectrum techniques where all users share all the channel resources. Multiple users are distinguished by assigning unique identification codes ("Pn codes") specific to each signal. Each user may transmit multiple signals (e.g., voice, data, video, etc.). Individual detection is accomplished at the receiver through correlation of the Pn codes to the particular signal.

A traditional way to separate the various signals received from different transmitters using CDMA is called a "rake receiver." A rake receiver includes a searcher and a plurality of fingers. The searcher examines the signal, and determines the number of rays, or multi-paths, for each Pn code and the offset of each path. A particular Pn code commonly has a plurality of multi-paths due to reflections against buildings, terrain such as mountains, or other obstacles. A finger of the rake receiver is assigned to each specific multi-path, assuming the rake receiver has enough fingers. For example, if three multi-paths are detected, the first finger (F_0) is provided the p-offset for that multi-path. In the same way, F_1 is set to the second multi-path, and further fingers are assigned until the number of multi-paths or the number of fingers is exhausted, up to F_{n-1}. The rake receiver then includes an accumulator which adds the signal component from each finger tracking a multi-path for that signal.

While reasonably effective, the rake receiver suffers from several disadvantages. First, to maximize the signal to noise ratio, the number of fingers should be at least equal to the number of multi-paths detected. Any additional fingers, however, increase hardware costs and the likelihood that fingers will be wasted. Conversely, if there are too few fingers, the signal to noise ratio of the receiver system is decreased.

It should also be noted that the rake receiver requires a searcher to identify all multi-paths with the desired Pn code. In addition, the p-offset associated with a particular multi-path is subject to variance, so the searcher must scan for changes in the multi-path during the entire transmission. Changes in the Pn code associated with each multi-path are due to a number of factors, including changes in the position of the transmitter, which is often mobile, as well as variances in the terrain and other obstacles in which the signals are reflected and transmitted.

Brief Description of the Drawings

The present invention is illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings and in which like reference numerals refer to like elements and in which:

FIG. 1 illustrates a simple schematic of a prior art transmitter/receiver pair showing multiple rays traversing distinct multi-paths to reach the receiver.

FIG. 2 illustrates, in block format, the multi-path delay and scan range functionality of the X-Y receiver in accordance with the present invention.

FIG. 3 illustrates, in block diagram format, the basic principles of the X-Y receiver of the present invention, including the scanning procedure, storage bar and combiner.

FIG. 4 illustrates, in block format, the basic principles of multi-path locating and cluster tracking.

FIG. 5 illustrates, in block format and in greater detail, the operation of the input circular data buffer structure of the X-Y receiver depicted in FIG. 3.

FIG. 6 illustrates, in block format and in greater detail, the operation of correlator bank structure of the X-Y receiver depicted in FIG. 3.

FIG. 7 illustrates, in block diagram format, the X-Y receiver of the present invention configured for multiple users.

Description of a Preferred Embodiment

The present invention is an X-Y, base-band receiver for CDMA. In CDMA, the received signal may be delayed by different reflections between the transmitter and base station. In addition, the transmitted signal may be transmitted by a series of mobile station transmitters at different distances. In the present invention, an X-Y receiver is used at the base station, which may be fixed or mobile. FIG. 1 shows a simple schematic of a transmitter 1 and receiver 2. The transmitter 1 may transmit various symbols A, B, C, *etc.* In CDMA, each such symbol has a specific pre-identified Pn code. Each symbol transmitted from the transmitter 1 may reach receiver 2 *via* various rays, R_0, R_1, . . .R_{M-1}.

The present invention uses an X-Y receiver to search for all instances of a specific Pn code. Signals are input into circular buffer 11, in the form of I, Q baseband samples. Referring to FIG. 2, the X-Y receiver continually searches a preselected scan window 3 for all multi-paths for a specific signal, *e.g.* A. Each instance of A, *e.g.*, A_0, A_1, A_2, *etc.*, are placed in a X-Y memory 20. Once the X-Y receiver has completed scanning the scan window 3, the X-Y memory 20 contains all instances of A within the scan window 3. The instances are added together in combiner 21 upon cycle completion. The X-Y receiver obviates the need for the fingers required by the rake receiver. By scanning for all instances of A, all desired multi-paths are accumulated in the X-Y memory 20 and added to enhance the signal to noise ratio.

The locations of each ray are randomly distributed in a limited range, which is equal to the maximum delay for the channel shown in FIG. 2 by the maximum delay window 4. The size of the maximum delay window 4 is directly proportional to the distance between the transmitter 1 and receiver 2. Referring again to FIG. 2,

a maximum delay window is defined which is comprised of D "chips," where a chip is the time period in which a Pn code is transmitted. A scan window 3 of length M is defined, where $M = \alpha$ D chips. In the preferred embodiment, $1 < \alpha < 2$.

The X-Y receiver scans the received signal within the scan window 3 for instances of A, B, C, *etc.* This may be accomplished by correlating the Pn codes specific to A, for example, to each chip measured. The X-Y receiver continues to scan for instances of A throughout the scan window 3. Each time an instance of A is identified, the information is transmitted to X-Y memory 20. When the entire scan window 3 has been scanned and all instances of A have been saved in the X-Y memory 20, the total signal is accumulated in combiner 21 and stored for later processing.

Still referring to FIG. 2, each offset, m_o, m_1, m_2 . . . M_{M-1} will drift back and forth in an apparently random fashion due to the mobile movement of the transmitter and other factors. In addition, the energy strength of each ray will also vary with time due to channel flat fading and other known phenomena. Accordingly, in one embodiment the scan window 3 is modified during operation of the receiver 2 so that all rays continue to be captured. This operation, known as "cluster tracking," will be discussed in greater detail below.

Referring now to FIG. 3, we see I,Q baseband samples in units of chips, which represent the transmitted message. The scan window 3 may be of length α D. The X-Y receiver begins the scanning following the first offset m_o, which is dependent upon which symbol is being scanned. For example, the X-Y receiver only scans for B following a time period equivalent to N chips which represents one symbol in the transmitted message. When scanning for A, the correlator 10

begins with offset 0, and continues until the offset equals M_{M-1}. Whenever the correlator 10 detects the Pn code for A, that symbol is entered into a X-Y memory 20 for that symbol. The de-spreaded symbol from the correlator 10 is stored in the X-Y memory 20. Following completion of one scan of the scan window for that symbol, the information from the buffer is sent to a combiner 21 where the combined output is transmitted for further processing.

X-Y memory 20 may be a storage bar, and is used to store de-spreaded symbols. The de-spreaded symbol from the M_{th} ray is stored in unit M of the storage bar. There are M_{eff} units in the buffer 20, where M_{eff} is the number of maximum possible available rays and M_{eff} is <= M.

Following a complete cycle, once the X-Y receiver has completely scan the scanned window 3 for a given symbol, *e.g.*, A, then the X-Y receiver begins to scan for symbol B, again storing the de-spreaded symbol in the X-Y memory 20.

FIG. 4 shows the basic theory behind multi-path locating and cluster tracking. In FIG. 4, the X-axis represents the ray offset, whereas the Y-axis represents time. The horizontal bars represent the scan window 3 applied by the X-Y receiver during a given time period. As can be seen, in one embodiment of the invention, the scan window 3 may shift along the X-axis to accommodate drift due to the movement of the transmitter. All multi-paths from the same transmitter form a multi-path cluster. The scan window 3 with a size of $M = \alpha D$ (in units of chips) can track the cluster drift. To accomplish this, each individual multi-path must be recognized *via* peak detection algorithms, which are known to those skilled in the art.

Referring now to FIG. 5, in one embodiment of the invention, multiple samples may be taken on a single chip. For I,Q samples, a plurality of circular

buffers may be used to take in n samples per chip from the I,Q inputs. Each of the n circular data buffers 30, 31, 32 will have T units. Number n samples taken from one chip period will be stored in n buffers. The buffers may be implemented as RAM in the base station. N is typically a factor of 2, such as 4, 8, or 16.

FIG. 6 shows an embodiment of the correlator bank in greater detail. In FIG. 6, the X-Y receiver scans the scan window 3 for instances of a particular channel, either a pilot channel or a data channel 0 to L-1. The buffer writer 40 writes the sample to input circular buffer 20. Buffer 20 is then read by a buffer reader 41, which outputs the sample to the correlator for the associated channel 42, 43, or 44. The correlator 42, 43, or 44 obtains the de-spreading code for the particular symbol via input 60, and outputs the I and Q channel data to the pilot bank 47 in the case of the pilot channel or to the data bank 47 in the case of the data channels. The pilot bank 60 information may be input into the cluster tracker 47 and the channel estimator 48. The feedback of the channel estimator 48 is input into the symbol combiner 21 for the combiner algorithm. The output of the cluster tracker 47 is used to modify the scan window 3 for the various symbols.

The data bank 46 stores information for each multi-path of each data channel from 0 to L-1. That data is then input into the symbol combiner 21 and output for further processing.

FIG. 7 shows a multi-user X-Y receiver structure. For K users, K correlator banks (shown as 50 and 52 in FIG. 7) track the Pn codes assigned to each channel. The number of samples per chip, n, defines the number of input circular buffers (shown as 30 and 32 in FIG. 7). All correlator bank associated with the n-th sample will share the same input circular buffer. One correlator bank corresponds to one user and has one output. The X-Y memory contains K banks, where each

bank corresponds to one user. The symbol combiner 21 performs the symbol combining function for each code channel. In one embodiment, there is also a cluster tracker 47 to track each cluster's drift and provide feedback drift information to the correlator bank 50, or 52, for tracking.

In one embodiment, a pilot signal is used by the transmitter 1 and receiving base station 2 to detect multi-paths and associated Pn offsets.

While the invention has been described in the context of a preferred embodiment, it will be apparent to those skilled in the art that the present invention may be modified in numerous ways and may assume many embodiments other than that specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the invention which fall within the true scope of the invention.

Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments. However, the benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential feature or element of any or all the claims. As used herein, the terms "comprises," "comprising," or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus.

Claims

What is claimed is:

1. A chip rate base band processor which receives digital information containing symbol information and provides a symbol output, comprising:

an input memory which stores the digital information;

a data PN code buffer;

a pilot PN code buffer;

a pilot multiplier having a first input coupled to the pilot PN code buffer, a second input coupled to the input memory, and an output;

a data multiplier having a first input coupled to the data PN code buffer, a second input coupled to the input memory, and an output;

a pilot accumulator having an input coupled to the output of the first multiplier, and an output;

a pilot memory coupled to the first accumulator;

a channel estimator coupled to the pilot memory;

a peak detector coupled to the pilot memory;

a data accumulator coupled to the data multiplier;

load controller having a first input coupled to the peak detector, a second input coupled to data accumulator, and an output;

a data memory coupled to the load controller;

a phase rotator having a first input coupled to the channel estimator, a second input coupled to the data memory, and an output; and

a symbol combiner having an input coupled to the phase rotator, and an output which provides the symbol output.

2. The chip rate base band processor of claim 1 further comprising a cluster tracker having an input coupled to the pilot memory, and an output coupled to the pilot PN code buffer.

3. The chip rate base band processor of claim 1 wherein the output of the cluster tracker is coupled to the data PN code buffer.

4. A chip rate base band processor which receives digital information containing symbol information and provides a symbol output, comprising:

an input memory which stores the digital information;

a pilot correlator having an input coupled to the input memory, and an output;

a data correlator having an input coupled to the input memory, and an output;

a pilot memory coupled to the pilot correlator;

a channel estimator having an input coupled to the pilot memory, and an output;

a data memory having an input coupled to the data correlator;

a phase rotator having a first input coupled to the output of the channel estimator, a second input coupled to the data memory, and an output; and

a symbol combiner having an input coupled to the output of the phase rotator, and an output which provides the symbol output.

5. The chip rate base band processor of claim 4 further comprising a second data correlator coupled to the input memory.

6. The chip rate base band processor of claim 5 further comprising:

a second data memory coupled to the second data correlator;

a second phase rotator having a first input coupled to the output of the channel estimator, a second input coupled to the second data memory, and an output; and

a second symbol combiner having an input coupled to the output of the phase rotator, and an output which provides the symbol output.

7. In a chip rate base band processor which receives digital information containing symbol information, wherein each symbol of the symbol information is of a predetermined time duration, a method comprising the steps of:

storing the digital information;

multiplying a PN code with a first segment, representative of the predetermined time duration, of the stored digital information and

multiplying the PN code with a second segment, representative of the predetermined time duration, of the stored digital information.

8. In a chip rate base band processor which receives digital information containing symbol information, wherein each symbol of the symbol information is of a predetermined time duration, a method comprising the steps of:

storing the digital information; and

successively multiplying a first PN code with a first plurality of segments of the stored digital information, wherein each segment is representative of the predetermined time duration.

9. The method of claim 8 further comprising successively multiplying a pilot PN code with the first plurality of segments of the stored digital information.

10. The method of claim 8, wherein the first PN code is a data code.

11. The method of claim 8, wherein the first PN code is a pilot code.

12. The method of claim 8, further comprising multiplying a second PN code with a second plurality of segments of the stored digital information, wherein each segment is representative of the predetermined time duration.

13. The method of claim 12, wherein the first PN code and the second PN code are data PN codes.

14. The method of claim 13 further comprising:

successively multiplying a first pilot PN code with the first plurality of segments of the stored digital information; and

successively multiplying a second pilot PN code with the second plurality of segments of the stored digital information.

15. A chip rate base band processor which receives digital information containing symbol information, wherein each symbol of the symbol information is of a predetermined time duration, a method comprising the steps of:

a memory which stores digital information representative of a plurality of the predetermined time durations;

a first multiplier coupled to the memory; and

a first PN code buffer coupled to the first multiplier.

16. The chip rate base band processor further comprising a incrementer means for successively outputting a portion of the digital information from the memory to the multiplier in segments representative of the predetermined time duration.

17. The chip rate base band processor of claim 16 further comprising:

a second multiplier coupled to the memory; and

a second PN code buffer coupled to the second multiplier.

X-Y RECEIVER FOR CDMA TRANSMISSION

ABSTRACT

An X-Y, base-band receiver for code-division multiple accessing ("CDMA") is used at both base station and mobile station. The signal transmitted from a transmitter carries serial information symbols. Signals from all transmitters pass through a multi-path fading channel before they are received by the X-Y receiver. There is more than one instance of each symbol. The X-Y receiver searches for all instances of each symbol and combines all instances.

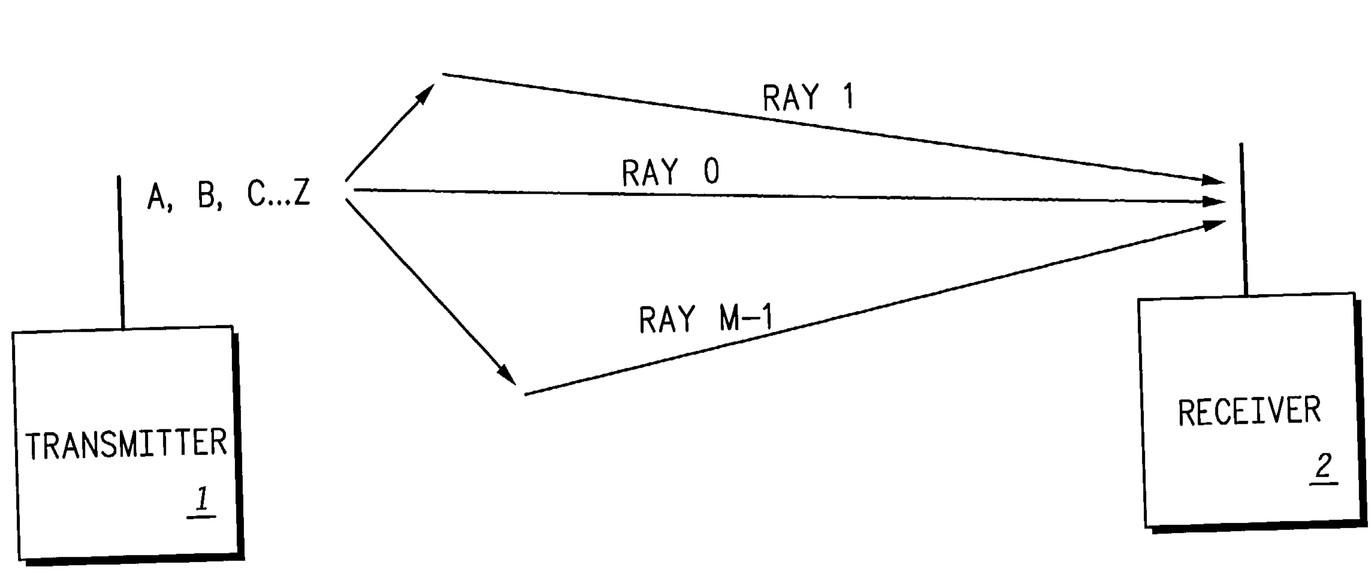

FIG.1
-PRIOR ART-

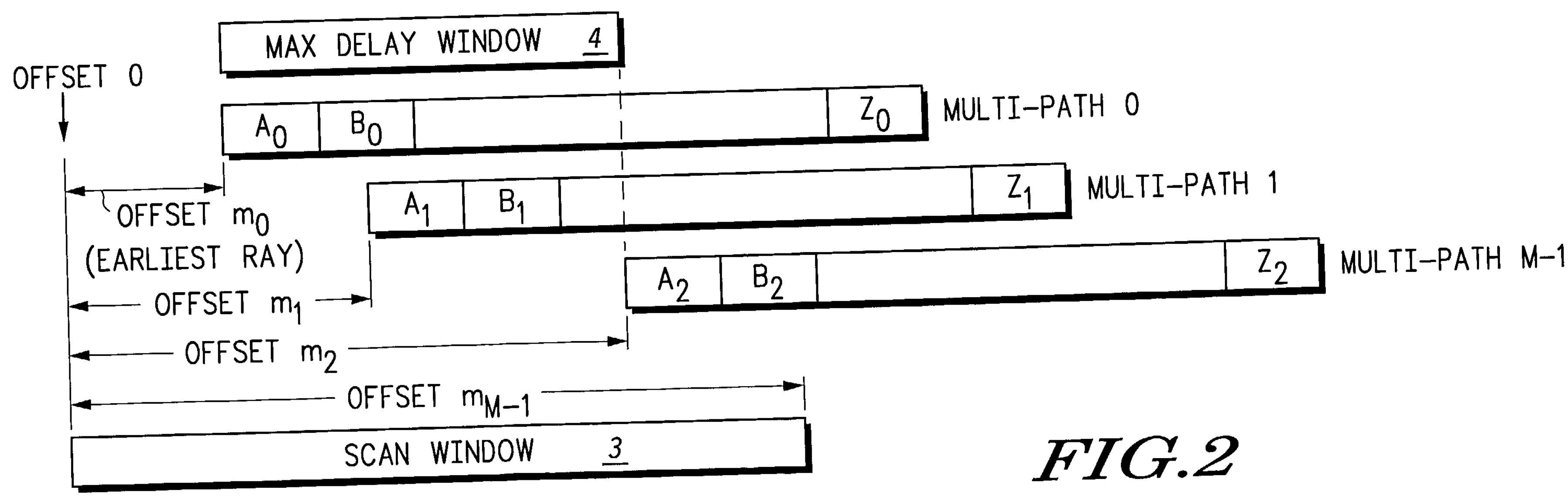

FIG.2

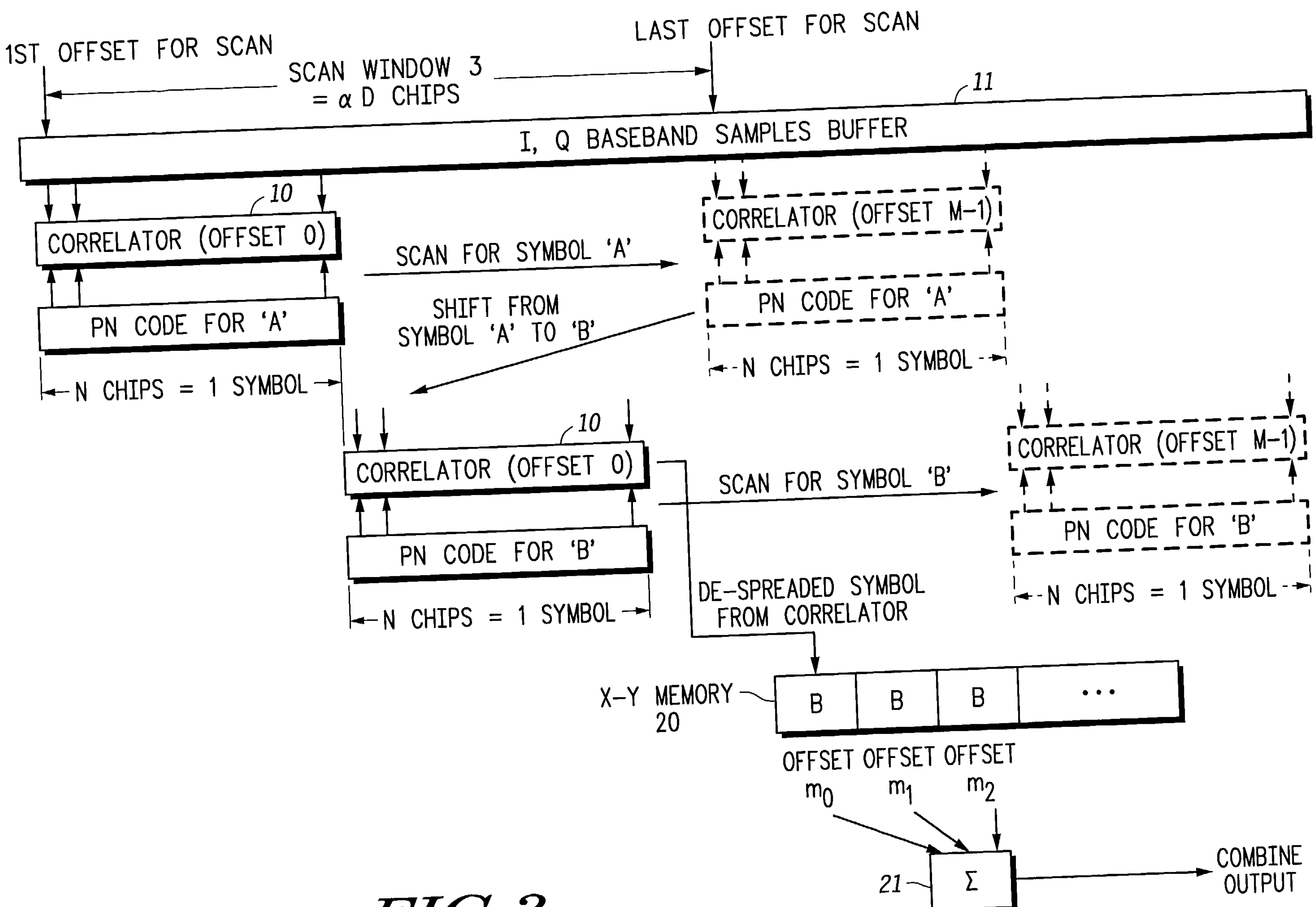
1ST OFFSET FOR SCAN
SCAN WINDOW 3
= α D CHIPS
LAST OFFSET FOR SCAN
11
I, Q BASEBAND SAMPLES BUFFER
10
CORRELATOR (OFFSET 0)
PN CODE FOR 'A'
N CHIPS = 1 SYMBOL
SCAN FOR SYMBOL 'A'
SHIFT FROM
SYMBOL 'A' TO 'B'
CORRELATOR (OFFSET M-1)
PN CODE FOR 'A'
N CHIPS = 1 SYMBOL
10
CORRELATOR (OFFSET 0)
PN CODE FOR 'B'
N CHIPS = 1 SYMBOL
SCAN FOR SYMBOL 'B'
CORRELATOR (OFFSET M-1)
PN CODE FOR 'B'
N CHIPS = 1 SYMBOL
DE-SPREADED SYMBOL
FROM CORRELATOR
X-Y MEMORY
20
B
B
B
...
OFFSET OFFSET OFFSET
m0 m1 m2
21
Σ
COMBINE
OUTPUT

FIG.3

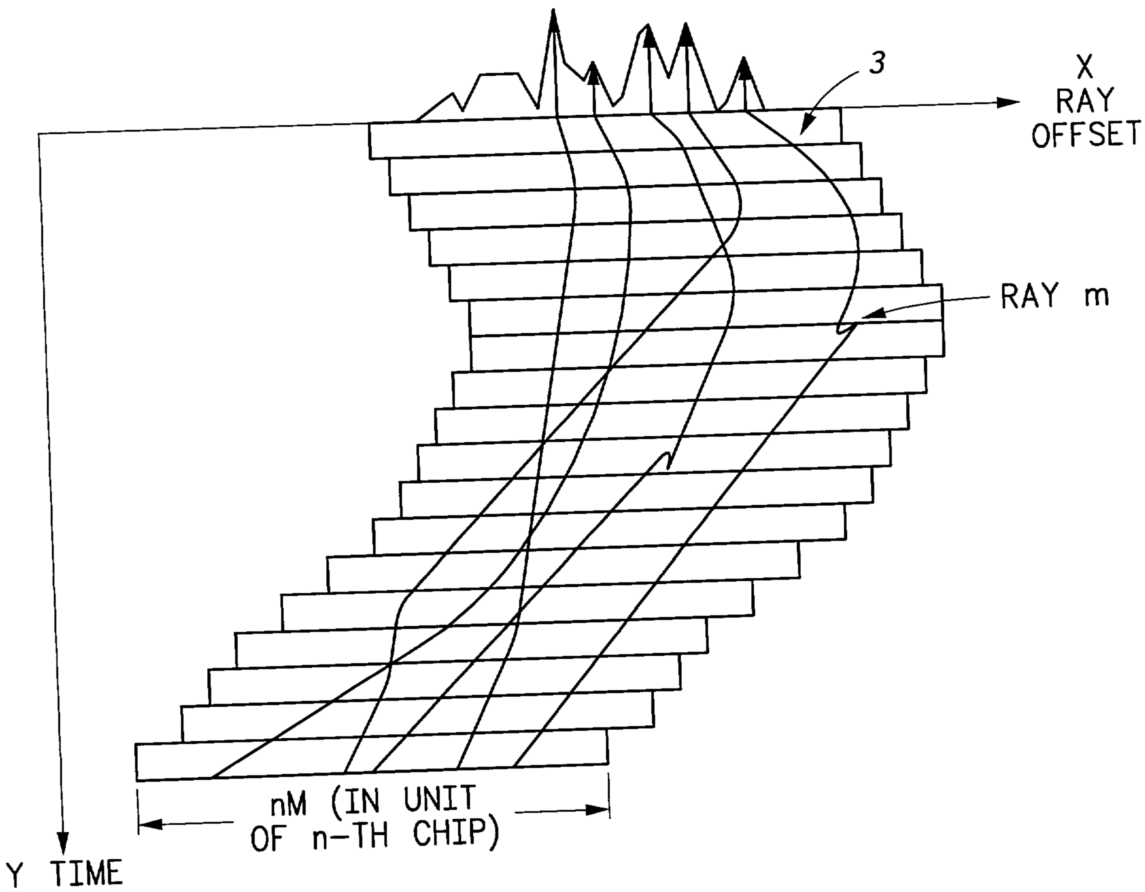
3
X
RAY
OFFSET
RAY m
nM (IN UNIT
OF n-TH CHIP)
Y TIME

FIG.4

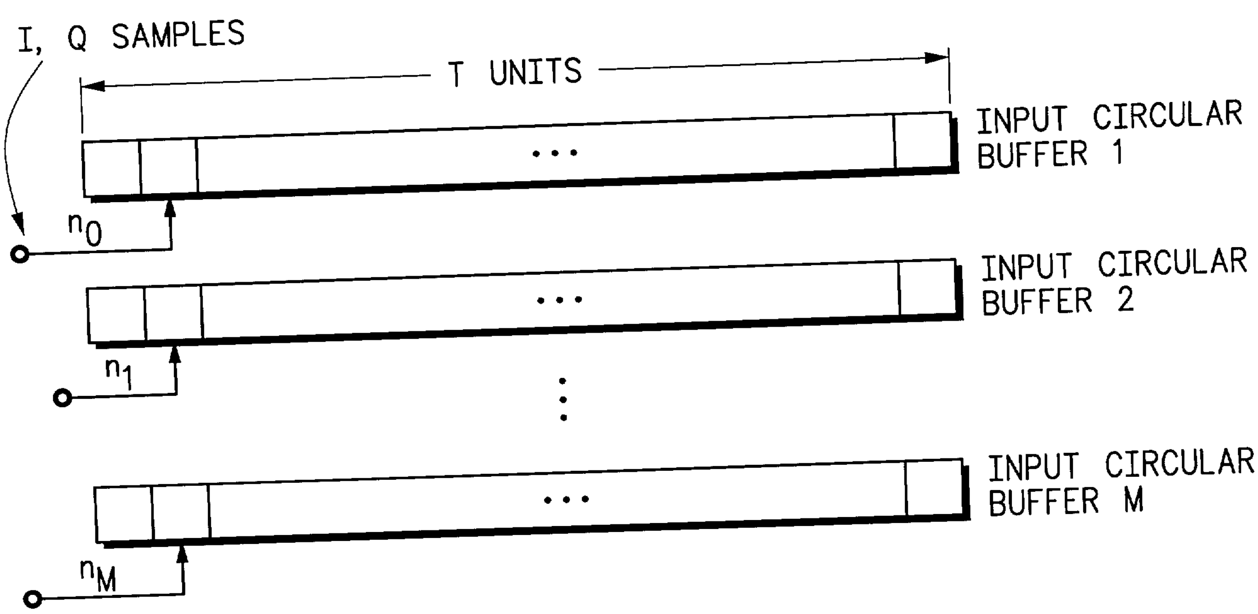
I, Q SAMPLES
T UNITS
INPUT CIRCULAR
BUFFER 1
INPUT CIRCULAR
BUFFER 2
INPUT CIRCULAR
BUFFER M
n_0
n_1
n_M

FIG.5

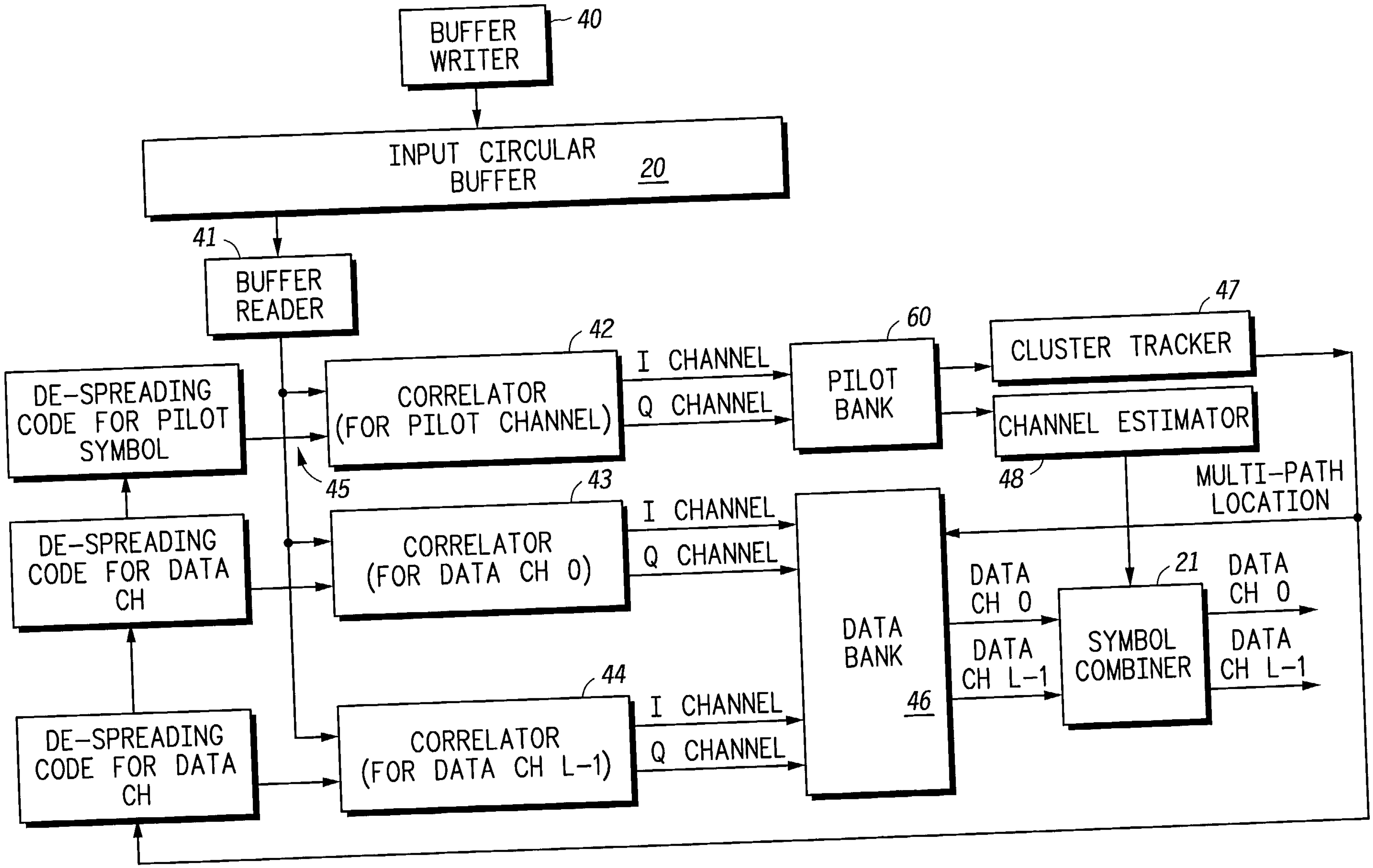
BUFFER WRITER
40
INPUT CIRCULAR BUFFER
20
41
BUFFER READER
DE-SPREADING CODE FOR PILOT SYMBOL
DE-SPREADING CODE FOR DATA CH
DE-SPREADING CODE FOR DATA CH
45
42
CORRELATOR (FOR PILOT CHANNEL)
43
CORRELATOR (FOR DATA CH 0)
44
CORRELATOR (FOR DATA CH L-1)
I CHANNEL
Q CHANNEL
I CHANNEL
Q CHANNEL
I CHANNEL
Q CHANNEL
60
PILOT BANK
DATA BANK
46
47
CLUSTER TRACKER
CHANNEL ESTIMATOR
48
MULTI-PATH LOCATION
DATA CH 0
DATA CH L-1
21
SYMBOL COMBINER
DATA CH 0
DATA CH L-1

FIG.6

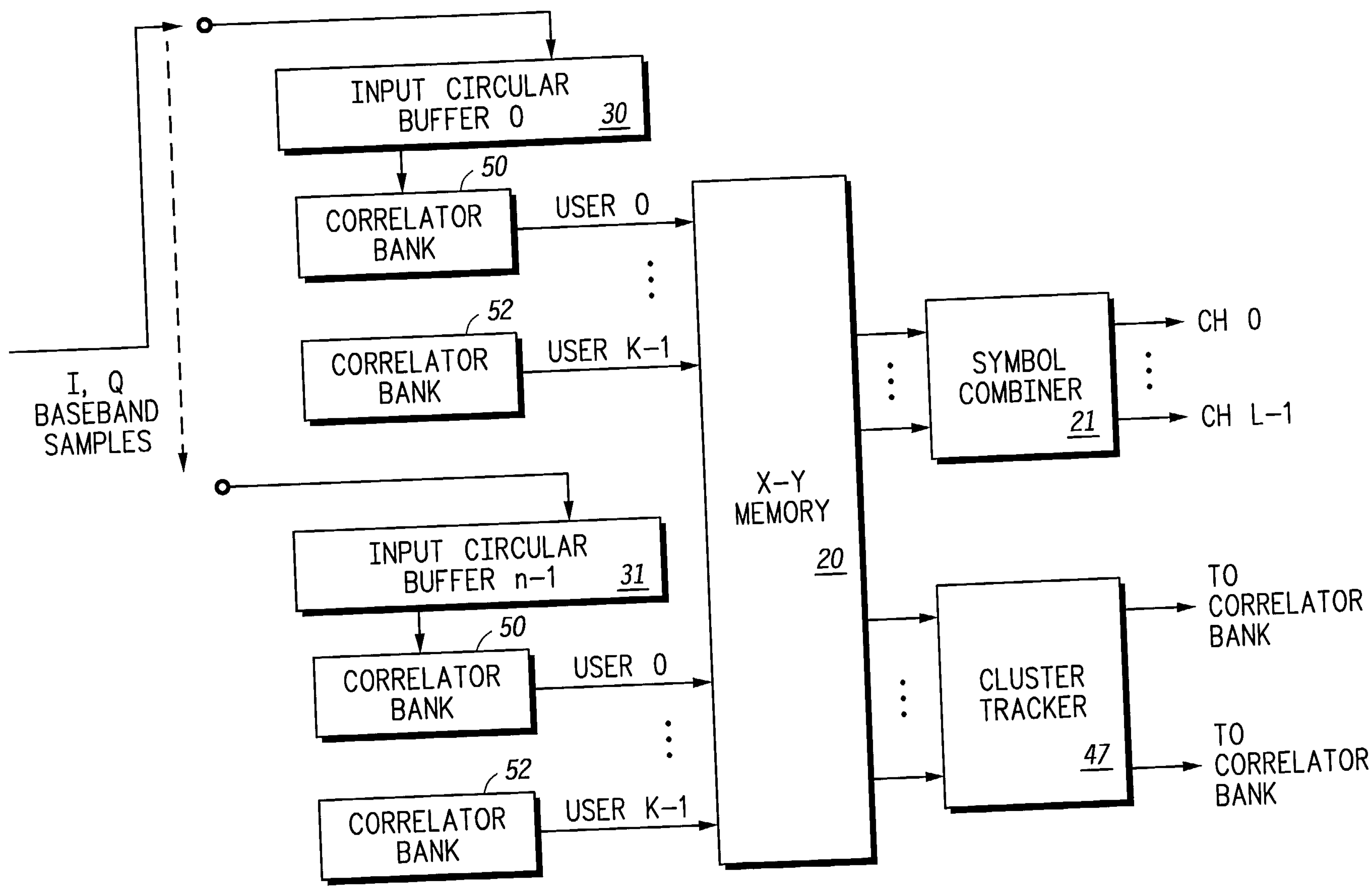
I, Q
BASEBAND
SAMPLES
INPUT CIRCULAR
BUFFER 0
30
CORRELATOR
BANK
50
USER 0
CORRELATOR
BANK
52
USER K-1
INPUT CIRCULAR
BUFFER n-1
31
CORRELATOR
BANK
50
USER 0
CORRELATOR
BANK
52
USER K-1
X-Y
MEMORY
20
SYMBOL
COMBINER
21
CH 0
CH L-1
CLUSTER
TRACKER
47
TO
CORRELATOR
BANK
TO
CORRELATOR
BANK

FIG. 7

COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

Attorney Docket SC91189A

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below), or an original, first and joint inventor (if plural names are listed below), of the subject matter which is claimed and for which a patent is sought on the invention entitled X-Y RECEIVER FOR CDMA TRANSMISSION, the specification of which is attached hereto unless the following line is marked:

____ Application was filed on ________________________________
as Application No. ________________________________
and was amended on ________________________________.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with 37 C.F.R. §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Claimed
____________	____________	____________	___ Yes ___ No
(Number)	(Country)	(Day/Month/Year Filed)	
____________	____________	____________	___ Yes ___ No
(Number)	(Country)	(Day/Month/Year Filed)	

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below.

________________________	________________________
(Application Number)	(Filing Date)
________________________	________________________
(Application Number)	(Filing Date)

I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the

prior United States application in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)
(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

Harry A. Wolin, Reg. No. 32,638; James L. Clingan, Reg. No. 30,163; Robert L. King, Reg. No 30,185; Paul J. Polansky, Reg. No. 33,992; M. Kathryn Braquet Tsirigotis, Reg. No. 34,127; George R. Meyer, Reg. No. 35,284; Lee E. Chastain, Reg. No. 35,479; Daniel D. Hill, Reg. No 35,895; Susan C. Hill, Reg. No. 35,896; Keith E. Witek, Reg. No. 37,475; Jeffrey G. Toler, Reg. No. 38,342; Michael P. Noonan, Reg. No. 42,038; Joanna P. Gariazzo, Reg. No. 43,629; Robert A. Rodriguez, Reg. No. P-45,049; Steven G. Parmelee, Reg. No. 28,790; J. Ray Wood, Reg. No. 36,062; Daniel K. Nichols, Reg. No. 29,420.

Direct all telephone calls to Mr. James L. Clingan, Jr. at telephone no. (512) 996-6839.

Address all correspondence to Harry A. Wolin, Motorola, Inc., Austin Intellectual Property Law Section, 7700 West Parmer Lane, MD: TX32/PL02, Austin, Texas 78729.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

FULL NAME OF SOLE INVENTOR	INVENTOR'S SIGNATURE	DATE
Chengke Sheng		11/5/1999
RESIDENCE:		CITIZENSHIP
12166 Metric Boulevard #281, Austin, Texas 78758		People's Republic of China
POST OFFICE ADDRESS		
Same as above		